

CLAIMS

1. A gate turn-off thyristor of a wide-gap semiconductor, comprising:

5 a first emitter layer of either one of n-type and p-type conductive types having a first electrode on its one surface;

a first base layer of a conductive type different from that of the first emitter layer provided on the other surface of the first emitter layer;

10 a second base layer of a conductive type identical to that of the first emitter layer provided on the first base layer;

15 a mesa-type second emitter layer of a conductive type different from that of the first emitter layer provided on the second base layer;

a second electrode provided on the mesa-type second emitter layer;

20 a low-resistance gate region provided so as to surround the mesa-type second emitter layer in a region located apart from an end portion of a junction between the mesa-type second emitter layer and the second base layer, the low-resistance gate region formed in a region that extends from a neighborhood of the end portion of the junction to a bottom portion of the mesa-type second  
25 emitter layer with interposition of the second base layer

between the region and the junction, the low-resistance gate region having a conductive type identical to that of the second base layer and an impurity concentration higher than that of the second base layer; and

5                   a third electrode put in contact with an end portion of the low-resistance gate region.

2.           The gate turn-off thyristor of a wide-gap semiconductor as claimed in claim 1, wherein

10                   a low-resistance region is provided by making the low-resistance gate region have an impurity concentration in the neighborhood of the junction thereof with the third electrode higher than an impurity concentration of the other portion of the low-resistance gate region.

15           3.           The gate turn-off thyristor of a wide-gap semiconductor as claimed in claim 1, wherein

                  the low-resistance gate region is provided in the second base layer in the neighborhood of the junction  
20           between the second emitter layer and the second base layer.

4.           The gate turn-off thyristor of a wide-gap semiconductor as claimed in claim 1, further comprising:

                  a region having a conductive type identical to  
25           that of the second emitter layer and provided in the second

base layer in the neighborhood of the end portion of the junction between the second base layer and the second emitter layer.

5        5.            The gate turn-off thyristor of a wide-gap semiconductor as claimed in claim 1, wherein

             a low-resistance gate region having a conductive type identical to that of the second base layer and provided at a bottom portion of a mesa that includes the  
10 neighborhood of the junction between the mesa-type second emitter layer and the second base layer in a neighborhood of a surface of the second base layer, with interposition of a region of a conductive type identical to that of the second emitter layer between the low-resistance gate region  
15 and the end portion of the junction.

6.            The gate turn-off thyristor of a wide-gap semiconductor as claimed in claim 1, further comprising:

             a low-resistance region having a conductive type  
20 identical to that of the second base layer and provided in a position located apart from the junction between the mesa-type second emitter layer and the second base layer in a neighborhood of a surface of the second base layer;

             a third electrode put in contact with the low-  
25 resistance region; and

a region of a conductive type identical to that of the second emitter layer provided in the second base layer in the neighborhood of the end portion of the junction between the second base layer and the second emitter layer.

7. The gate turn-off thyristor of a wide-gap semiconductor as claimed in claim 1, wherein

the second base layer is formed into a mesa type, and a low-resistance gate region of a conductive type identical to that of the second base layer is formed in the first base layer so that the region surrounds the mesa-type second base layer.

8. The gate turn-off thyristor of a wide-gap semiconductor as claimed in claim 1 or 7, further comprising:

at least one low-resistance small region of a conductive type identical to that of the low-resistance gate region formed inside the low-resistance gate region.

9. The gate turn-off thyristor of a wide-gap semiconductor as claimed in claim 1, wherein

the first emitter layer is an n-type cathode emitter layer, the first base layer is a p-type base layer,

the second base layer is an n-type base layer, the second emitter layer is a p-type anode emitter layer, and the low-resistance gate region is an n-type, and

5 the first, second and third electrodes are a cathode electrode, an anode electrode and a gate electrode, respectively.

10. The gate turn-off thyristor of a wide-gap semiconductor as claimed in claim 1, wherein

10 the first emitter layer is a p-type anode emitter layer, the first base layer is an n-type base layer, the second base layer is a p-type base layer, the second emitter layer is an n-type cathode emitter layer, and the low-resistance gate region is a p-type, and

15 the first, second and third electrodes are an anode electrode, a cathode electrode and a gate electrode, respectively.

11. The gate turn-off thyristor of a wide-gap semiconductor as claimed in claim 1, wherein

20 the wide-gap semiconductor is silicon carbide (SiC).

12. The gate turn-off thyristor of a wide-gap semiconductor as claimed in claim 1 or 8, wherein

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an impurity concentration of the low-resistance gate region is three or more times an impurity concentration of the base region.

5 13. A gate turn-off thyristor of a wide-gap semiconductor, comprising:

a first emitter layer of either one of n-type and p-type conductive types having a first electrode on its one surface;

10 a first base layer of a conductive type different from that of the first emitter layer provided on the other surface of the first emitter layer;

a second base layer of a conductive type identical to that of the first emitter layer provided on  
15 the first base layer;

a mesa-type second emitter layer of a conductive type different from that of the first emitter layer provided on the second base layer;

a contact electrode put in contact with the mesa-  
20 type second emitter layer in a region excluding a central region of the second emitter layer;

a low-resistance region provided so as to surround the mesa-type second emitter layer in a region located apart from an end portion of a junction between the  
25 mesa-type second emitter layer and the second base layer,

the low-resistance region having a conductive type identical to that of the second base layer and an impurity concentration higher than that of the second base layer; and

5                   a second electrode put in contact with an end portion of the low-resistance region.

14.           A gate turn-off thyristor of a wide-gap semiconductor, comprising:

10                   a first emitter layer of either one of n-type and p-type conductive types having a first electrode on its one surface;

                  a first base layer of a conductive type different from that of the first emitter layer provided on the other  
15                   surface of the first emitter layer;

                  a second base layer of a conductive type identical to that of the first emitter layer provided on the first base layer;

                  a mesa-type second emitter layer of a conductive  
20                   type different from that of the first emitter layer provided on the second base layer;

                  a high-resistance region provided in a central region of an upper surface of the second emitter layer and having a conductive type identical to that of the second

emitter layer and an impurity concentration lower than that of the second emitter layer;

a contact electrode put in contact with the second emitter layer and the high-resistance region;

5 a second electrode put in contact with the contact electrode and the second emitter layer at least at a peripheral portion of the contact electrode and having a contact resistance to the emitter layer greater than a contact resistance of the contact electrode to the emitter  
10 layer;

a low-resistance region provided so as to surround the mesa-type second emitter layer in a region located apart from an end portion of a junction between the mesa-type second emitter layer and the second base layer,  
15 the low-resistance region having a conductive type identical to that of the second base layer and an impurity concentration higher than that of the second base layer; and

a third electrode put in contact with an end  
20 portion of the low-resistance region.

15. The gate turn-off thyristor as claimed in any one of claims 1, 13 and 14, further comprising:



a region of a conductive type different from that of the second emitter layer provided in a central region of an upper surface of the mesa-type second emitter layer; and

5 a second electrode located opposite to the second emitter layer and the region via at least a contact electrode.

16. The gate turn-off thyristor as claimed in any one of claims 1, 13 and 14, further comprising:

10 a heavily doped region provided in a central region of a surface of the second base layer and having a conductive type identical to that of the second base layer and an impurity concentration higher than that of the second base layer;

15 a mesa-type second emitter layer provided on the second base layer and the heavily doped region and having a conductive type different from that of the first emitter layer; and

20 a second electrode put in contact with the mesa-type second emitter layer at least via a contact electrode.